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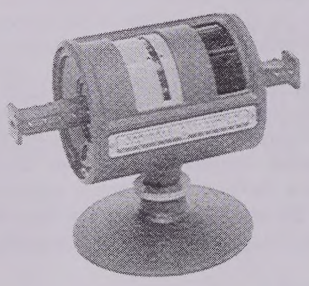
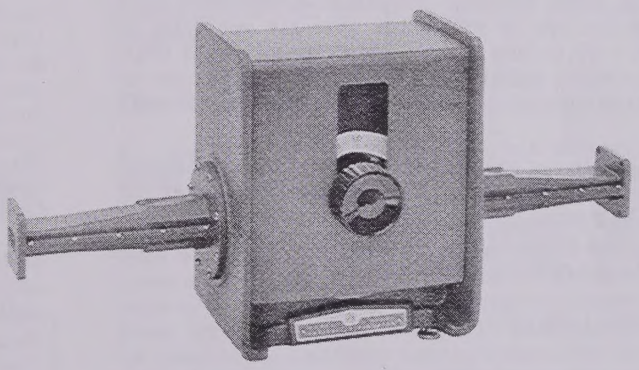
AGILENT 382A (HP)

OPERATING AND SERVICE MANUAL

HP 382A
VARIABLE ATTENUATOR



K and R382A



H, X and P382A
G and J have round flanges

Printed: MAY 1984

HEWLETT PACKARD

Table 1. Specifications

Model	Frequency Range (GHz)	Fits Waveguide Size		Flange UG	Power Capacity*	Length		Height		Depth		Weight	
		(in.)	(EIA)			(in.)	(mm)	(in.)	(mm)	(in.)	(mm)	(lb)	(kg)
G382A	3.95-5.85	2 x 1	WR187	407/U[3]	15	31-5/8	803	9-5/8	245	7-3/4	197	25	11.3
J382A	5.3-8.2	1-1/2 x 3/4	WR137	441/U[3]	10	25	635	7-7/8	200	6-3/16	157	14	6.3
H382A	7.05-10.0	1-1/4 x 5/8	WR112	138/U	10	20	508	7-15/16	202	6-1/2	165	12	5.4
X382A	8.2-12.4	1 x 1/2	WR90	135/U	10	15-5/8	397	7-5/8	194	4-11/16	119	5	2.3
P382A	12.4-18.0	0.702 x 0.391	WR62	Cover (Al)	5	12-1/2	318	7-3/4	197	4-3/4	121	5	2.3
K382A[1]	18.0-26.5	1/2 x 1/4	WR42	597/U	2	7-5/8	194	6-1/8	156	4-3/4	121	3	1.4
R382A[2]	26.5-40.0	0.360 x 0.220	WR28	Cover (Al)	1	6-3/8	162	6-1/8	156	4-3/4	121	3	1.4

Incremental Attenuation Range[4]: 0-50 dB.
Residual Attenuation[5]: Less than 1 dB.
Reflection Coefficient: Less than 0.07 (1.15 SWR), entire range of attenuation and frequency.
Incremental Attenuation Accuracy: ±2% of the reading in dB, or 0.1 dB, whichever is greater. Includes calibration and frequency response.

*Power handling capacity, watts, average continuous duty.
[1] Circular flange adapters available: HP 11515A (UG-425/U).
[2] Circular flange adapters available: HP 11516A (UG-381/U).
[3] Circular flanges.
[4] New terminology for "Calibrated Attenuation Range."
[5] New terminology for "Insertion Loss."

1. DESCRIPTION.

2. Model 382A Variable Precision Attenuators are designed for use in waveguide systems operating in the 3.95 - 40.0 GHz range. Each model of the 382A series provides calibrated attenuation of from zero to 50 dB at any frequency within the rated waveguide band.

3. Attenuation is read directly on the dial. Residual (attenuation at zero setting) is less than 1 dB over the waveguide range. Backlash is less than 0.3 dB at 50 dB. The SWR is low and variation of phase with setting is practically negligible.

4. INITIAL INSPECTION.

5. MECHANICAL CHECK. If damage to the shipping carton is evident, ask that the carrier's agent be present when the instrument is unpacked. Inspect the instrument for mechanical damage such as scratches, dents or broken knobs. Also check the cushioning material for signs of severe stress (compacting).

6. PERFORMANCE CHECK. The electrical performance of the 382A should be verified as soon as possible after receipt. A performance check suitable for incoming inspection is given in Paragraphs 31 through 51.

7. CLAIM FOR DAMAGE. If the 382A is mechanically damaged or fails to meet specifications on receipt, notify the carrier and the nearest Hewlett-Packard office immediately. (A list of field offices is at the back of this note.) Retain the shipping carton and the padding material for the carrier's inspection.

8. HANDLING.

9. CARE OF FLANGES.

10. Take care to prevent damage to the face of the coupling flanges. Any scoring of the mating surfaces tends to increase the separation of the flange faces and will cause increased leakage and loss, particularly where a current maximum and voltage minimum occur at the flange. When storing the 382A, be sure to replace the flange covers to preclude damage to the flanges.

11. AVOID VERTICAL SHOCK.

12. When shipping or handling a Model G, H, or J382A in a manner which will subject it to shocks in a vertical plane, always set the attenuation dial to zero. With the dial at zero, danger is minimized that vertical shocks will cause the attenuator flag to move downward, releasing tension on the drive cable. When the tension is released, the drive cable can jump out of the grooved portion of the drum, in which case the flag will be positioned approximately half-way between the scales. If this should occur, the trouble is easily remedied: remove the cover and slip the cable back into its groove on the drum. The accuracy of the attenuator will not be affected in any way.

13. OPERATION.

14. ALIGN FLANGES.

15. The height of the Model 382A should be adjusted carefully so that precise alignment will be obtained at the coupling flanges to prevent undue strain on one flange while the other is unsupported. A screw at each corner of the base will enable height and leveling adjustments to be made. When the instrument is supported at both ends, as in permanent installations, the feet or base may be removed altogether, if desired (K or R bands).

16. DO NOT FORCE DIAL STOPS.

17. When setting attenuation do not force the dial against the mechanical stops at the ends of the attenuation range. Forcing the dial can change the calibration.

18. SETTING ATTENUATION.

19. Attenuation is set by the knob and read directly on the dial. A white background strip moves behind the dial window to select the range to read (not on K, or R band). Read only the range with the white background. The MAX setting gives the maximum attenuation - at least 70 dB at all frequencies.

20. PRINCIPLES OF OPERATION.

21. Basically the attenuator consists of three sections of waveguide in tandem. In each section a resistive film is placed across the guide as shown in Figure 1. The middle section is a short length of round guide which is free to rotate radially with respect to the two fixed end sections. The end sections are rectangular-to-round waveguide transitions in which the resistive films are normal to the E field of the applied wave. The construction is symmetrical and the device is bidirectional.

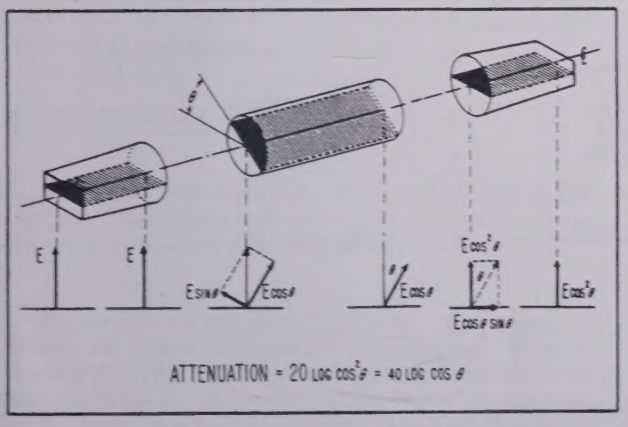


Figure 1. Attenuation Principle

22. When all films are aligned, the E field of the applied field is normal to all films. When this occurs, no current flows in the films and no attenuation occurs. If the center film is rotated to some angle θ, the E field can be considered to be split into two orthogonal components: E sin θ in the plane of the film, and E cos θ at right angles to it. The E sin θ component is absorbed by the film, while the E cos θ component oriented at an angle θ with respect to the original wave, is passed unattenuated to the third section. When it encounters the third film, the E cos θ sin θ component is absorbed, and the E $\cos^2 \theta$ component emerges at the same orientation as the original wave.

23. The attenuation is thus ideally proportional only to the angle to which the center film is rotated and is completely independent of frequency. In dB terms the attenuation is equal to 40 log cos θ.

24. Maximum attenuation of the attenuator exceeds the 50 dB calibrated range by at least 20 dB but the characteristics in this range are not controlled. Theoretically, the attenuator is capable of very high attenuation. In practice this property is modified by the fact that the resistive film in the middle section cannot completely absorb the E sin θ component. Hence, a small leakage component is passed to the output. For high attenuation above 50 dB, the leakage component begins to approach the magnitude of the desired output of the attenuator. Ultimate attenuation of this device thus becomes limited by the attenuation of the center rotating film which is 70 dB or more.

25. The accuracy of the attenuator does not depend on the stability of the resistive films: as long as their attenuation is high and remains high, performance is not affected.

26. SOURCES OF ERROR.

27. One of the principle sources of error in the Model 382A is internal reflections and finite attenuation in the center film. Reflections are minimized by tapers on the films and careful design of the transitions and choke joints. The center film attenuation is made as great as possible, consistent with low reflections and reasonable length and is at least 70 dB. Since this attenuation does vary with frequency it is not possible to calibrate the instrument all the way to 90° rotation (maximum attenuation). A margin of about 20 dB is necessary to maintain accuracy, so calibration is carried to 50 dB.

28. Another principle source of error is higher-order mode propagation in the circular waveguide. The other modes (TM_{01} and TE_{21}) can exist in addition to the wanted TE_{11} mode. The TM_{01} mode is equally attenuated at all angles of the center section but cannot be attenuated completely. The TE_{21} mode should not be excited if the choke sections and transitions are perfectly aligned. In practice, however, the choke sections are not perfectly matched at all frequencies. Therefore, above cutoff of the TE_{21} mode, in the top one-quarter of the frequency band, some sharp resonances could occur unless these modes are suppressed. Polyiron grooves are added in the center section to overcome these sources of error.

Table 2. Test Equipment Required

The following are test instruments and accessories required for performance checking. Test instruments other than those listed may be used provided their performance equals or exceeds the Critical Specifications.

Instrument Type	Critical Specifications	Recommended HP Model
Sweep Oscillator*	Frequency: band of 382A Internal AM: 1000 Hz square wave Leveling: ±0.5 dB from external signal Sweep Output: for recorder	8690 series
Directional Couplers (3) (1 with calibration curve)	Coupling: 10 dB ±0.4 dB Directivity: >40 dB	752C
Calibrated Variable Attenuator	Attenuation: 0 to 50 dB Insertion Loss: <1 dB SWR: <1.15 over entire range	382A
Crystal Detectors (3)	Frequency: band of 382A Response: flat, no tuning	424A
SWR Meter	Frequency: 1000 Hz Input Impedance: 200K ohm Output: compatible with Recorder	415E
WG-Coaxial Adapter	SWR: <1.25	281A
X-Y Recorder with 1000 Hz Filter	Compatible with SWR Meter and Sweep Oscillator used	7035B
Waveguide Short	Frequency: band of 382A	920A, B, X923A in X-band
Moveable Load	Frequency: band of 382A SWR: <1.01	914A/B

*May need additional TWT Amplifier depending upon band, output, sensitivity of detector, etc. A TWT Amplifier should not be used unless necessary due to increased noise level.

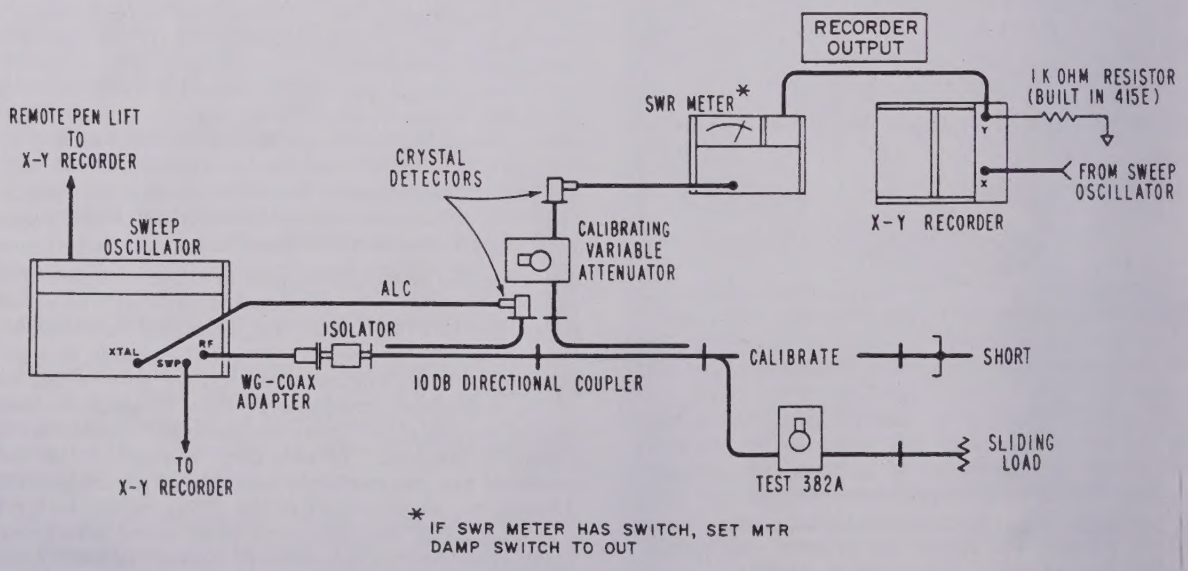


Figure 2. RF Pre-Insertion - X-Y Recorder Setup for ρ Tests

TABLE 3. TEST CARD

Hewlett-Packard Model 382A

Instrument Serial No _____ Date _____

Test Performed By _____

Description of Test	Test Limits
Standing Wave Ratio	_____ SWR $\leqq$ 1.15
Residual Attenuation	_____ Residual Attenuation $\leqq$ 1.0 dB
Attenuator Calibration	_____ 10 dB ±(0.2 dB - mismatch error)
	_____ 20 dB "
	_____ 30 dB "
	_____ 40 dB "
	_____ 50 dB "

29. TEST CARD.

30. Table 3 outlines the test procedure necessary to determine if the Model 382A meets specifications. Space is provided for recording the test results.

31. PERFORMANCE TESTS.

32. Perform the following tests as Incoming Inspection test, whenever repair work has been done on the attenuator, or whenever the performance of the attenuator is suspected.

33. STANDING WAVE RATIO.

34. This test will obtain the SWR by measuring the reflection coefficient and calculating the SWR. Connect the instruments as shown in Figure 2.

35. Procedure for using this set-up consists of shorting the output (100% reflection) and then drawing a calibration grid of traces on the recorder around the expected value by varying the calibrating attenuator. For instance, if a reflection coefficient of 0.10 is expected, a calibration trace for this value at the frequencies swept by the sweep oscillator can be obtained by setting the calibrating attenuator to 20 dB. Attenuation values for setting the return loss by means of the calibrating attenuator for other reflection coefficients may be obtained either by means of a reflectometer calculator (obtainable from your local HP field office) or from the expression:

$$\text{Return Loss (dB)} = -20 \log_{10} \rho \ .$$

The negative sign in this expression merely indicates that this attenuation is a loss.

36. The effect of reflections from the load may be minimized by moving the load through at least a half-wavelength rapidly to present the maximum possible signal to the indicator at any frequency. However, the speed of moving the load must not be faster than the X-Y recorder can respond. When using this technique, the fact that the signal goes beyond the limits does not necessarily mean the attenuator is out of specifications (the reflections from the load and the attenuator may have added). The true value is the average of the small signal (fine grain) variations in the trace.

37. Set calibrating attenuator to zero and replace short with terminated attenuator to be tested. Trigger final sweep which will be the SWR versus frequency characteristics of the attenuator under test.

38. Since we wish to determine if the SWR is below 1.15, we can calibrate the reflectometer for this value and check that the attenuator under test stays below that value for all frequencies within its rated band. From a reflectometer calculator we obtain for SWR = 1.15 a return loss of 23.1 dB.

39. With the use of the reflectometer calculator (obtainable from your local HP field office or from the factory) the errors of such a set-up can be determined and taken into account. The return loss of a SWR of 1.15 is 23.1 dB, but taking into account the ambiguity due to the directional coupler directivity, the adjusted return loss setting will move to the lower end of the ambiguity limit: 24.5 dB. One more possible error that must be taken into account is the calibration error of the attenuator setting the value of the return loss (specifications call for ±2% or 0.1 dB whichever is greater). This figure will increase the ambiguity limit by 2% to 25 dB. There could be one more error involved in this measurement, namely the multiple-mismatch error due to the change of attenuator setting of the Model 382A attenuator with respect to the detector and the auxiliary arm of the directional coupler. This error can be neglected if at least 10 dB of attenuation is left always in the attenuator since the phase and magnitude of the reflection coefficient of the rotary-vane attenuator will not change appreciably if it is held above 10 dB at all times.

40. For the above reasons we will have to set a return loss of 25 dB for a SWR of 1.15. The procedure is as follows:

a. With the instruments connected as in Figure 2, the calibrating attenuator set to 35 dB, and the short connected, run a slow trace. If a moveable short is used, rapidly phase the short while sweeping. The average of the fine grain variation of the trace is the calibration curve.

b. Disconnect the short used for calibrating.

c. Connect one arm of the Model 382A under test to the setup where the short was originally connected.

d. Set the calibrating Variable Attenuator to 10 dB.

e. Connect a moveable load to the other port of the attenuator.

f. Set the Model 382A under test for 0 dB attenuation.

g. Trigger the sweep again. This is the test trace. If this trace approaches the calibration trace, phase (spin) the load rapidly during this trace to record all possible phases of the source and load mismatch. The actual test trace is the average of the fine grain variation of the recording. This procedure will balance out the source and load mismatch errors. Note, however, that this procedure does not correct for other system errors.

h. Repeat this measurement with the attenuator under test set to 10, 20, 30, 40, 50 dB and MAX attenuation. The SWR must remain less than 1.15 (25 dB return loss calibration line) throughout the frequency range of the attenuator under test. If any of these traces go through the calibration line the attenuator may or may not be out of specifications depending upon how the extra reflections in the system combine. To determine the true SWR at these doubtful frequencies use the single frequency SWR test which follows.

i. Connect the other port of the attenuator to the test setup and repeat steps d through h. If the SWR is out of specifications check for warped, broken, burned or wrinkled resistive cards. Check for silver paint or foreign material in rotary choke joints.

41. Single Frequency SWR Test. The swept frequency SWR test is preferred since it will show narrow out-of-specification bands which may be missed with spot checking by means of this single frequency method. However, if equipment for sweep testing is not available or if doubtful frequencies show up in sweep-frequency testing use the following test:

a. In the setup of Figure 2 connect a slotted line and SWR Meter between test setup and 382 under test.

b. Adjust carriage for maximum voltage on SWR Meter.

c. Adjust sliding load for maximum voltage on SWR Meter.

d. Repeat steps b and c since they interact.

e. Set GAIN on SWR Meter for a meter reading of 1.0.

f. Move carriage to minimum voltage position (maximum SWR).

g. Move sliding load to maximum voltage (minimum SWR). Do NOT readjust carriage.

h. Read SWR on meter. This is the true SWR of the 382 with the load reflection cancelled out. However, any possible reflections from other components of the system are not cancelled.

42. RESIDUAL ATTENUATION.

43. This test measures the minimum loss introduced into a system by the use of the Model 382A Variable Attenuator under test. Using the setup of Figure 3 proceed as follows:

a. Remove the test Model 382A from the setup and connect together.

b. With Sweep Oscillator set for single frequency operation at one end of the Model 382A band adjust Variable Attenuator to obtain SWR Meter reading of 3 dB on any convenient range. Sweep 382A frequency range and make X-Y plot. This plot represents 1 dB insertion loss (residual attenuation).

c. At frequency used in step b and without changing SWR Meter range, adjust Variable Attenuator to obtain SWR Meter reading of 2 dB. Sweep and make X-Y plot. This plot represents zero insertion loss (residual attenuation).

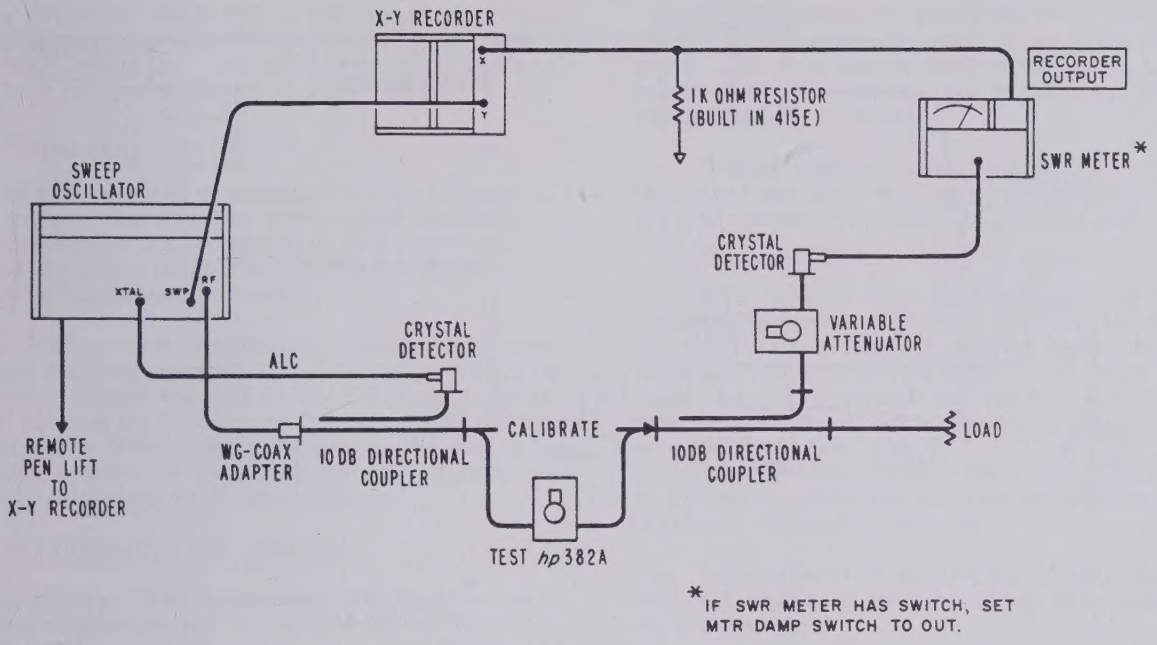


Figure 3. Residual Attenuation Setup

d. Without changing Variable Attenuator setting from step c insert Model 382A under test. Set Model 382A under test to 0 attenuation. Sweep and make X-Y plot. This X-Y plot should be between the calibration plots.

44. The following test determines that the attenuator is functioning at all frequencies and not just at the test frequencies. If the attenuator does not attenuate at certain frequencies (moding) spikes will appear on the attenuation curve. To obtain this curve proceed as follows:

a. Connect instruments as shown in Figure 4.

b. Set 382A under test to 50 dB.

c. Sweep a line for the entire frequency band of the Model 382A under test. There should not be any deviations from this curve such as spikes, etc. If such deviations exist change the center-section and retest.

45. BACKLASH.

46. Backlash must be checked before the calibration on the attenuator since any calibration done will be nullified if excessive backlash exists. To check backlash proceed as follows:

a. Connect instruments as shown in Figure 3.

b. Set the Model 382A under test to the 50 dB calibration mark.

c. Set Variable Attenuator for a reference on the SWR Meter.

d. Move dial to the right and then back to 50 dB. Read SWR Meter.

e. Move dial to left and then back to 50 dB. In both this step and the preceeding step the deviation of the meter from the reference point should not exceed ±0.2 dB.

f. If excessive backlash is found, refer to Figure 5 and complete the rest of the procedure. If the backlash is within specifications the remainder of the adjustments in this paragraph need not be performed.

g. Check the position of the Ring Nut. It should be backed off approximately 1/4 turn from snug against the bearing.

h. Adjust the Worm Gear Tension Adjustment Screw to minimize backlash.

i. Adjust the Worm Gear Thrust Adjustment Screw to minimize backlash.

If an adjustment is made for backlash check the dial positioning using the procedure of Paragraph 47.

47. SETTING THE DIAL.

48. The dial will need resetting if a new dial is installed, if the stops have been forced hard, or if the dial has slipped. To reset the dial connect as in Figure 3 and proceed as follows:

a. Set signal source to lowest point of Model 382A frequency range. Adjust the output RF signal for 1000 Hz square wave modulation.

b. Set Model 382A under test to dot which appears at approximately 47 dB on the attenuator dial. Adjust the Model 382A padding attenuator for a reference of 1 dB on the 50 dB range of the SWR meter.

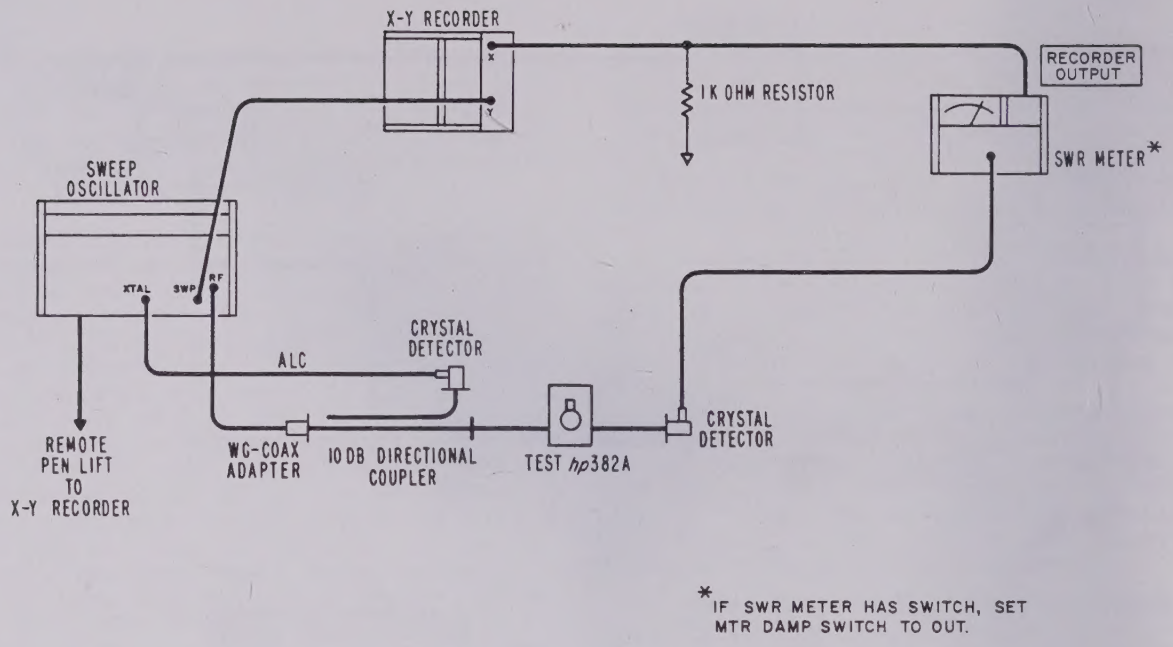


Figure 4. Moding Test Setup

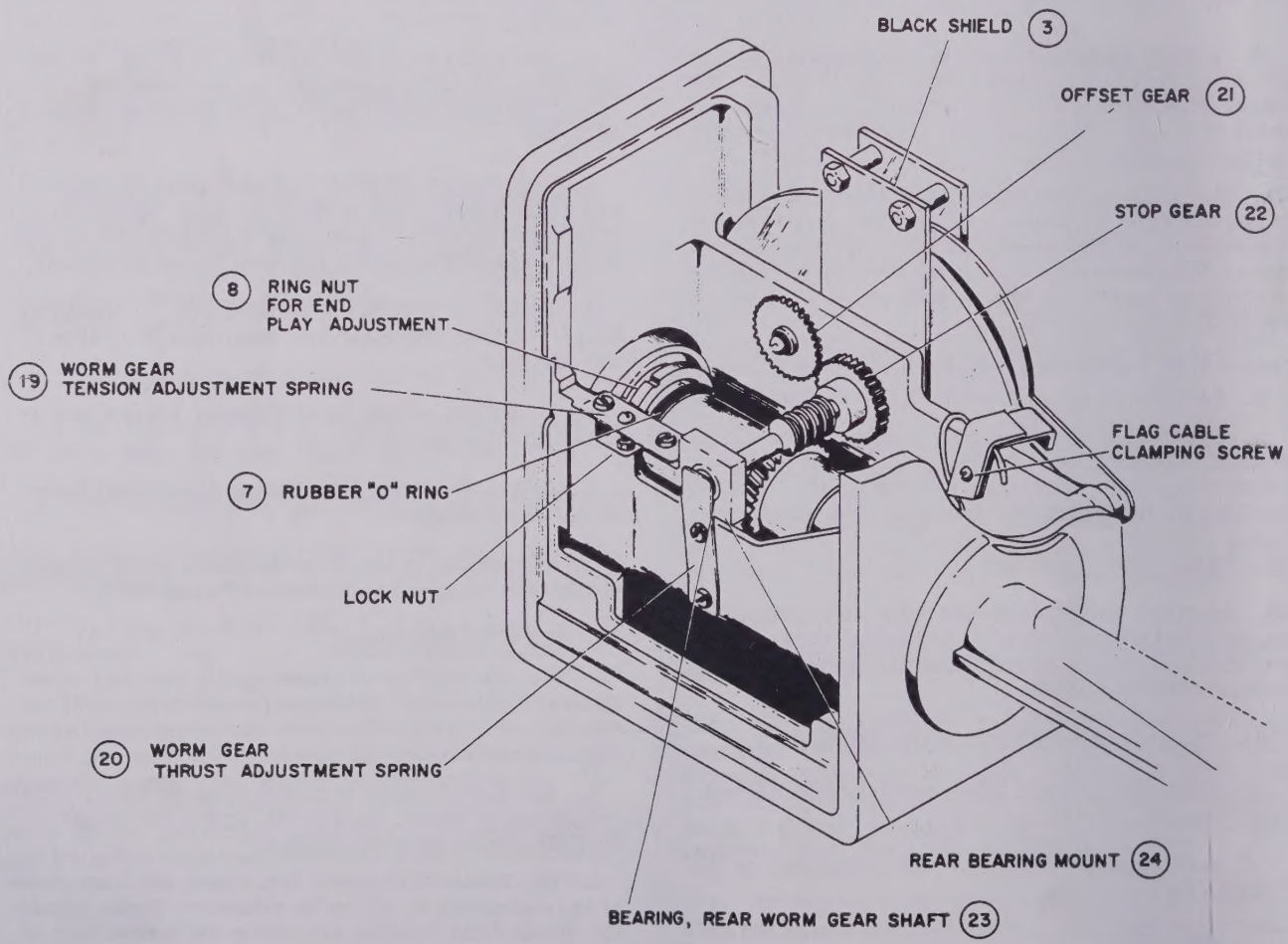

BLACK SHIELD (3)
OFFSET GEAR (21)
STOP GEAR (22)
(8) RING NUT FOR END PLAY ADJUSTMENT
(19) WORM GEAR TENSION ADJUSTMENT SPRING
FLAG CABLE CLAMPING SCREW
(7) RUBBER "O" RING
LOCK NUT
(20) WORM GEAR THRUST ADJUSTMENT SPRING
REAR BEARING MOUNT (24)
BEARING, REAR WORM GEAR SHAFT (23)

Figure 5. Backlash Adjustments

c. Set Model 382A dial to dot which appears approximately the same distance on the other side of the MAX indication. The SWR Meter reading should not have changed more than 0.2 dB.

NOTE

If a double peak in maximum attenuation occurs, the resistive center card has been installed with the emulsion side reversed. Refer to the replacement procedure for correct installation procedure.

d. If adjustment is necessary, loosen the setscrews and the dial hub clamping screw (see Figure 5) in the dial hub. Adjust the dial so the difference in power level between the two dots is 0.2 dB or less as indicated on the SWR Meter. This aligns the dial to the angular position of the center section. Tighten cap screw, Allen setscrews, and recheck.

49. ATTENUATOR CALIBRATION.

50. Calibrate 10 dB System Error. Since we are to calibrate the attenuator in 10 dB steps we must first calibrate the 10 dB attenuator on the SWR Meter. To do this we substitute a calibrated Directional Coupler. Proceed as follows:

a. Connect the instruments as shown in Figure 6.

b. Remove the Model 382A under test and reconnect the system (marked "CALIBRATE" in Figure 6).

c. Set Variable Attenuator to 41 dB.

d. Peak SWR Meter for maximum signal with 1000 Hz square wave modulation at one of the calibration frequencies of the calibrated Directional Coupler.

e. Set SWR Meter to the 40 dB range and set to a reference point about mid-scale on one of the expanded scales. Be sure this is well within the square-law region of the detector (see HP Journal July '66, Vol 17, No. 11, pp 9-13).

f. Connect input and auxiliary output of Directional Coupler at the point marked "CALIBRATE" in Figure 6 (terminate main line with matched load).

g. Set the SWR Meter to 50 dB range.

h. Read SWR Meter and determine attenuation change from reference reading. Subtract the calibration value. The remainder (with the appropriate sign) is the true value of the SWR Meter 10 dB range attenuation. Record this value and use it as the corrected reference point for all measurements at this frequency.

51. Calibrate Model 382A. The Model 382A can now be accurately calibrated since the error in the system is known. Proceed as follows:

a. Remove the Directional Coupler used as a standard and replace it with the Model 382A under test set to 0 dB.

b. Set SWR Meter to 40 dB and set to a reference point at the mid-scale on one of the expanded scales. The Variable Attenuator remains set at 41 dB as in the previous procedure.

c. Increase dial setting of Model 382A under test exactly 10 dB and set SWR Meter to 50 dB gain.

d. Read the error considering the range switching error determined in the previous procedure. Error (between steps or cumulative) must not be greater than ±(0.2 dB - mismatch error).

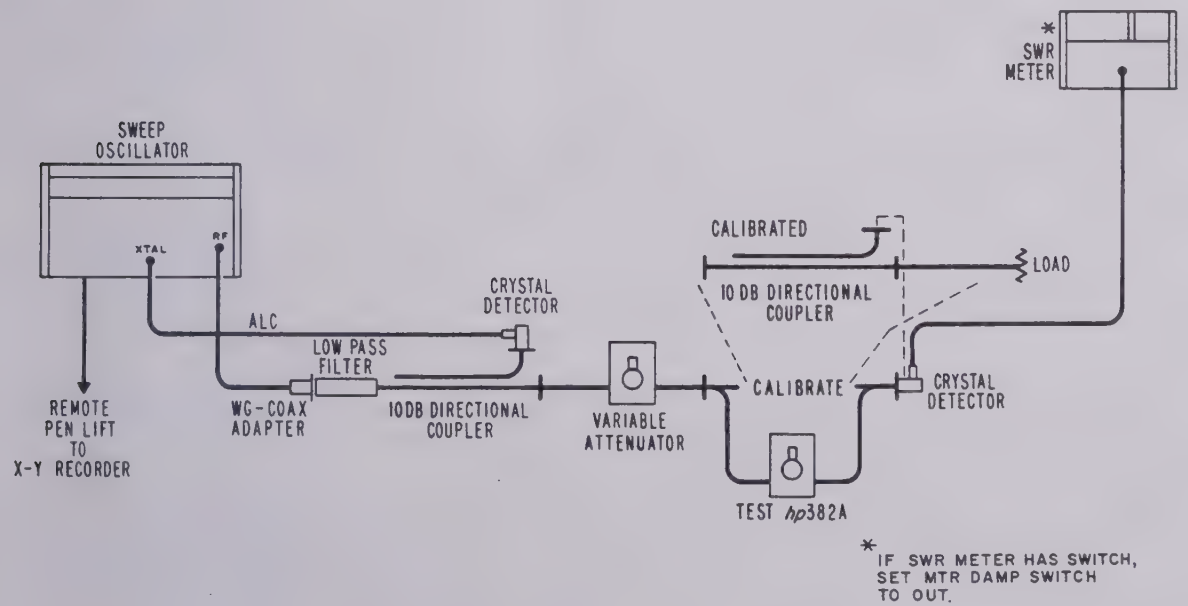


Figure 6. Attenuator Calibration

e. Set SWR Meter to 40 dB gain and Variable Attenuator to roughly 31 dB. Set a reference on an expanded scale as previously, taking into account the cumulative error. Repeat steps c and d.

f. Set SWR Meter to 40 dB gain and Variable Attenuator to roughly 41 dB. Set reference on an expanded scale as previously, taking into account the cumulative error. Repeat steps c and d.

g. Set SWR Meter to 40 dB gain and Variable Attenuator to roughly 51 dB. Set reference on an expanded scale as previously, taking into account the cumulative error. Repeat steps c and d.

h. Repeat Paragraphs 50 and 51 for all calibrated frequencies of the Directional Coupler standard. Apply calibration corrections to the results obtained.

52. This procedure tests the Model 382A with the maximum accuracy. However, if a calibrated coupler is not available or if a simpler procedure is desired, the Model 382A may be calibrated directly against an SWR Meter. This method has additional errors due to not being referred to a standard, having cumulative errors due to the SWR Meter attenuator, and due to the non-linearity of the crystal but may be used as a rough check.

53. MAINTENANCE.

54. No maintenance is required on the Model K382A. or the R382A. On other models, the only maintenance required is occasional lubrication of the bearing surfaces. The worm and worm gear, ball bearings, gears, flag shaft, and the ends of the center section (see Figure 5) should be lubricated with a light grease such as Lubriplate #105V made by Fiske Brothers Refining Co. Newark, New Jersey, and Toledo, Ohio.

55. REPLACING THE DIAL

56. Align the "0" placement on dial with "Max".

57. RESISTIVE CARD REPLACEMENT PROCEDURE.

58. Resistive cards can be replaced quickly and easily in HP Models G382A, J382A, H382A, X382A, and P382A Broadband Precision Waveguide Variable Attenuators by following these procedures. Models K382A, and R382A, should be returned to the factory for repair. The attenuation accuracy of your HP Model 382A is directly dependent upon the condition of its resistive elements. These elements are composed of precisely cut mica cards overlaid with an evaporated metal film. Accuracy is impaired if the card becomes damaged or the metal film is burned. The attenuating characteristics of the instrument then no longer follow the mathematical law for the attenuator.

59. Replacement of the damaged cards and calibration of the attenuator will restore the instrument to the specifications published for the unit.

60. Installation requires only disassembly of the end or center section (as necessary), positioning of the replacement resistive element card, reassembly of the unit, and calibration.

61. For your convenience stock numbers of replaceable parts for your HP Model 382A Variable Attenuator are included according to frequency band designations.

62. CARD REPLACEMENT PROCEDURE.

NOTE

To replace only end-section card, complete steps a(1), (5), (6); c(1)-(10); d(3)-(5), (7).

a. To Dismantle:

(1) Remove dial knob and dust cover (see Figure 7).

(2) Turn dial fully clockwise. Note: Center card passes thru the horizontal and meets a stop approximately 1/32 of an inch beyond this point (as measured at edge of card).

(3) Note position of flag with respect to dial. The flag should be at the bottom of travel and the dial "0" (zero) should be to right of the center line.

(4) Loosen clamping screws on flag drive cable. Free flag.

(5) Drive locator pins to center of unit with punch. See Figure 7. Note: In some models the drive pin is an integral part of the casting. If pins are not visible from the outside, disregard step 5.

(6) Remove the 8 screws holding the end section in place. Remove end section.

(7) With dial set to "0" (zero) mark top of center section as shown in Figure 7. Remove center section through end section opening.

NOTE

In the G, J, and H band models the center section can be removed only by removing the right end section.

b. Center Section Resistive Card Replacement:

(1) Remove flag cable from center section. Clean section. Drive locator pins from center section. Mark the position of the cable clamping device.

(2) Remove ring nut (lock nut) and rubber "O" ring from center barrel.

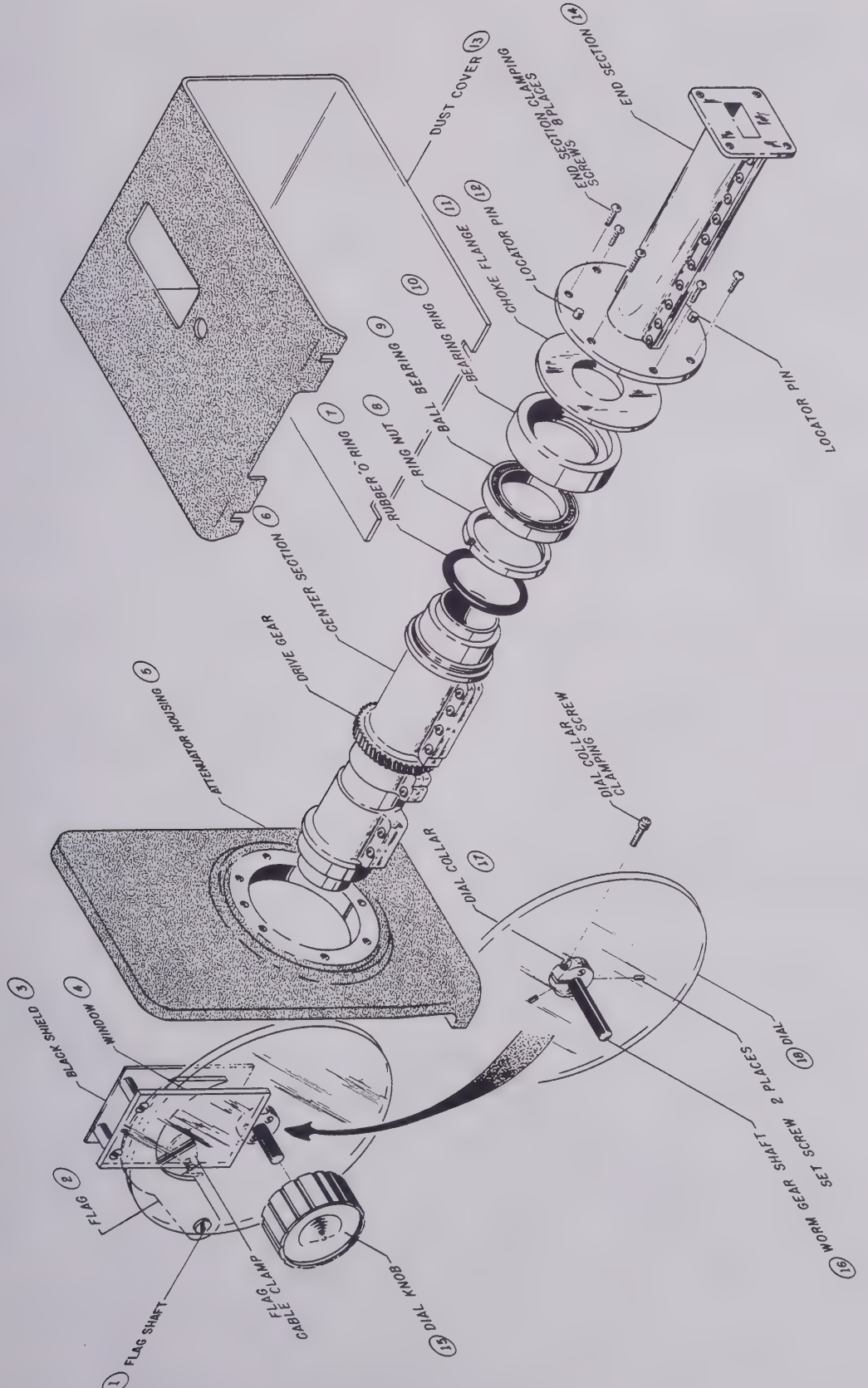


Figure 7. HP Model 382A Attenuator Assembly Detail

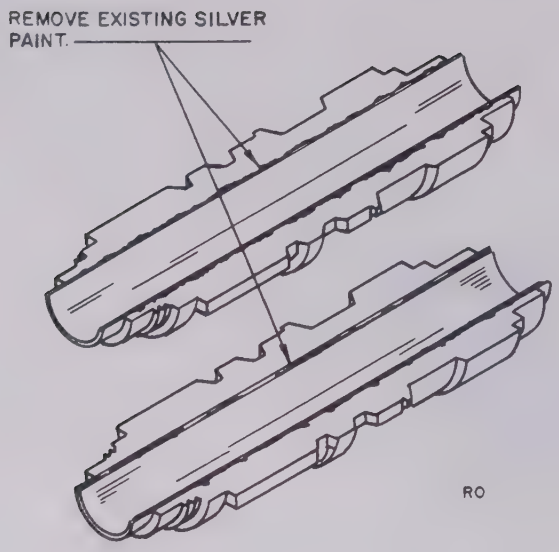


Figure 8. Removal of Existing Silver Paint

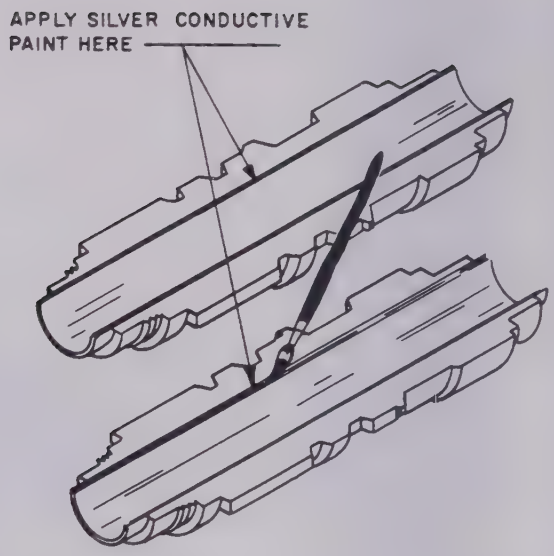


Figure 9. Application of Conductive Silver Paint to Center Section

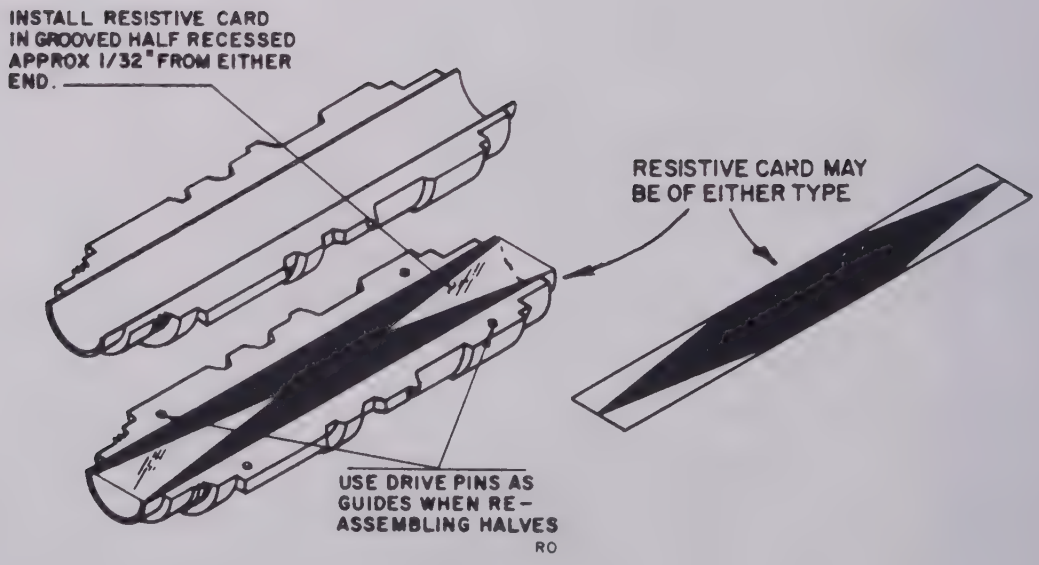

INSTALL RESISTIVE CARD IN GROOVED HALF RECESSED APPROX 1/32" FROM EITHER END.
RESISTIVE CARD MAY BE OF EITHER TYPE
USE DRIVE PINS AS GUIDES WHEN RE-ASSEMBLING HALVES
RO

Figure 10. Installation of Resistive Card in Center Section

(3) Remove screws and separate halves.

(4) Refer to Figure 8. Remove silver paint in card recess with acetone. This operation must be thorough. Any old paint left in recess may cause bowing of card. Note: Only one-half of center section is recessed for receiving attenuator card.

(5) Apply conductive silver paint (Handy and Harmon No. 169, HP Stock No. 6010-0006) along the edges of the center section halves as shown in Figure 9.

(6) Install center card with emulsion side up (deposited side) in the recessed center section half as shown in Figure 10. Note: To identify the emulsion side, scratch the extreme edge (that portion which will be covered by conductive paint). The emulsion side when scratched will become transparent.

(7) Replace drive pin in marked half of center section to act as guides. This is the half marked in step a(7). Replace top half of center section. Seat drive pins with pliers.

(8) Install screws in one side of barrel with screw heads on marked center section half.

(9) Tighten center section screws beginning in middle and working toward each end.

(10) Install screws on opposite side of barrel with heads in same direction as in step (8). Leave this side loose.

(11) Check card for wrinkles. If possible, compare with one known to be good.

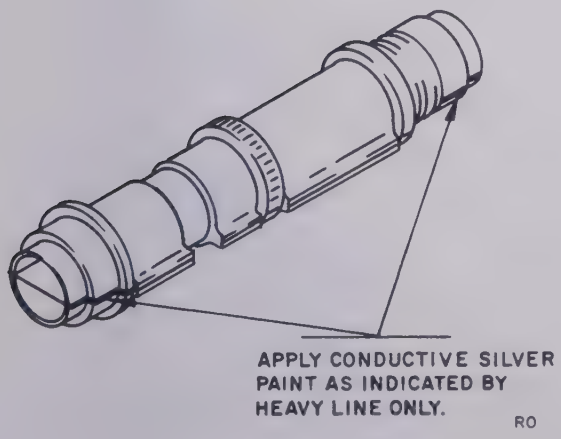


Figure 11. Application of Silver Paint to Choke Joint of Center Section

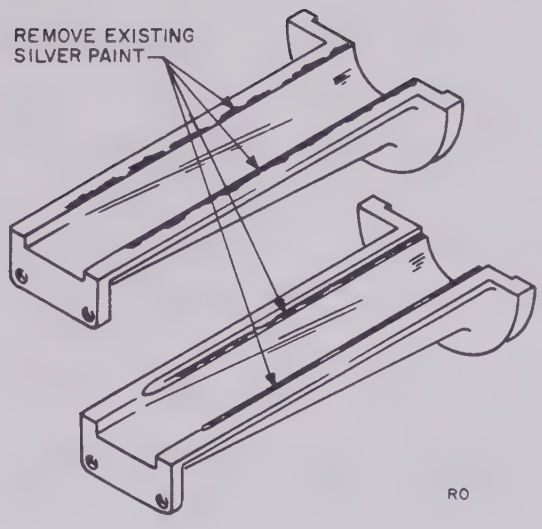


Figure 12. Removal of Silver Paint from End Section

(12) Remove excess wrinkles by tapping center section with plastic hammer on untightened seam. If wrinkles still exist, repeat with opposite side loose. Do not remove pins; just loosen screws. Note: Steps (5) thru (12) must be completed before silver paint dries (approximately 1/2 hour).

(13) Refer to Figure 11. Apply conductive silver to seams of choke joint on ends of center section.

IMPORTANT: Paint these ends well. Failure to do so will cause excessive insertion loss.

(14) Replace "O" ring and ring nut. Small OD should be outboard on ring nut.

c. End Section Resistive Card Replacement:

(1) Remove bearing ring and choke joint (light press fit).

NOTES

1. Choke joint may be part of end section. In this case the choke joint cannot be removed.

2. On "G" band unit, the chokes are held in place with screws.

(2) Drive locator pins from end section (see Figure 14).

(3) Remove screws and separate halves.

(4) Refer to Figure 12. Remove silver paint from both halves with acetone.

(5) Apply conductive silver paint along the inner edges of the end section halves as shown in Figure 13.

(6) Install end card with emulsion (deposited) side up in recessed half of the end section as shown in Figure 14.

(7) Replace top half. Seat drive pins with pliers.

(8) Install screws with heads up.

(9) Check card for wrinkles. If necessary, remove wrinkles as described in step b(12).

(10) Install choke and/or bearing ring. Make sure parts are properly seated.

d. Assembly:

(1) Turn dial fully clockwise.

(2) Insert barrel so center card is rotated 1/32 inch beyond the horizontal as noted in step a(2).

(3) Replace end section drive pins from end section side.

(4) Tighten end sections.

(5) Do not adjust screws on the flat springs of rear bearing block.

(6) Adjust ring nut (lock nut) on center barrel until snug. Then back off 1/8 turn.

(7) Check backlash by applying inward pressure on the knob end of the shaft. The shaft should move freely and spring back to its original position.

(8) Attach flag cable.

(9) Lubricate worm gear (recommended lubricant: Mobilux No. 1, Mfg. by Mobil Oil Co., or Moly Grease, HP Stock No. 6040-0012).

63. DIAL CORD REPLACEMENT.

(1) With dial set to 50, run cable through lug on center section and clamping screw.

(2) Position flag behind 50 and tighten clamp screw.

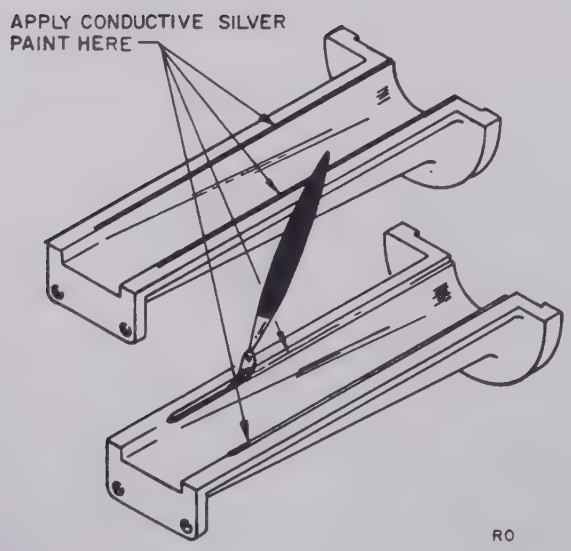


Figure 13. Application of Conductive Silver Paint to End Section

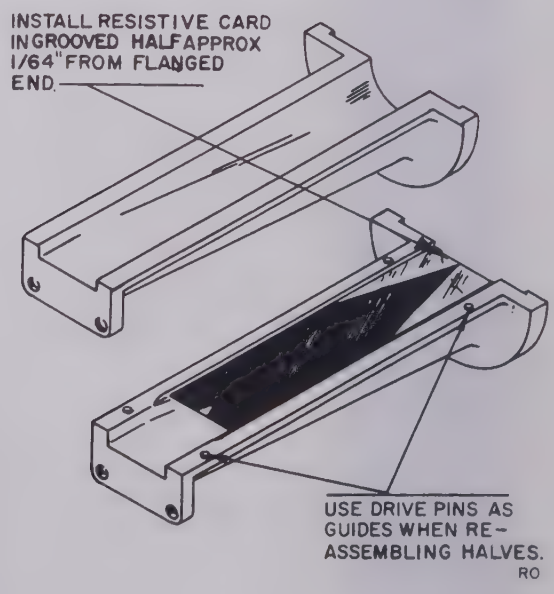

INSTALL RESISTIVE CARD IN GROOVED HALF APPROX 1/64" FROM FLANGED END.
USE DRIVE PINS AS GUIDES WHEN RE-ASSEMBLING HALVES.
RO

Figure 14. Installation of Resistive Card in End Section

64. REPLACEABLE PARTS LIST

65. Introduction

66. This section contains information of replaceable parts for servicing HP Model 382A.

67. Table 4 lists replaceable parts in alphanumerical order of their reference designators. Miscellaneous parts are included at the end of the list. Detailed information includes the following:

a. Reference designator.

b. Full description of the part.

c. Manufacturer of the part in a five-digit code; see list of manufacturers in appendix.

d. Part number check digit (CD).

e. Hewlett-Packard part number.

f. Total quantity used in the instrument (TQ column).

g. Recommended spare quantity for comparative maintenance during one year of isolated service (RS col.).

h. See Figure 7 for pictorial key to Ck Ref. Item numbers listed below.

68. Ordering Information

69. To obtain a replacement part listed in Table 4, order the part by the HP part number and Check Digit (CD). To order a part that is not listed, specify model and complete serial number of instrument, a description of the part and its function and location. Address order to your nearest Hewlett-Packard Field Office.

See following for G, H, J, P, X, K, and R bands.

Table 4. Replaceable Parts List

Ck Ref. Item	Description	Mfr.*	HP Part No.	CD	TQ*	RS*
1	Flag Shaft, Freq. Bands: G, H, J, P, X	28480	X382A-5	7	1	1
2	Flag Assembly, Freq. Bands: G	28480	G382A-7	9	1	0
	H, J	28480	J382A-20	4	1	0
	P, X	28480	X382A-3	5	1	0
3	Black Shield, Freq. Bands: G, H, J, P, X	28480	X382A-40	0	1	1
4	Window, Freq. Bands: G, H, J, P, X	28480	X382A-41	0	1	0
5	Attenuator Housing					
	Freq. Bands: G Moss grey finish	28480	00382-20015	6	2	0
	H, J Moss grey finish	28480	00382-20017	8	2	0
	P, X Moss grey finish	28480	00382-20019	0	2	0
6	Center Section (with Resistive Card)					
	Freq. Bands: G	28480	G382-95E	0	1	0
	H	28480	H382A-95E	5	1	0
	J	28480	J382-95E	0	1	0
	P	28480	P382A-95E	0	1	0
	X	28480	X382-95E	2	1	0
7	Rubber "O" Ring					
	Freq. Bands: G	02286	0900-0005	5	1	0
	H, J	02286	0900-0002	2	1	0
	P, X	02286	0900-0001	1	1	0

*See introduction to this section.

Table 4. Replaceable Parts List (Cont'd)

Ck Ref. Item	Description	Mfr.*	HP Part No.	CD	TQ*	RS*
8	Ring Nut					
	Freq. Bands: G	28480	G382A-6	6	1	0
	H, J	28480	J382A-3	3	1	0
	P, X	28480	X382A-7	9	1	0
9	Ball Bearing Center Barrel					
	Freq. Bands: G	21335	1410-0025	1	2	0
	H, J	21335	1410-0020	6	2	0
	P, X	21335	1410-0014	8	2	0
10	Bearing Ring					
	Freq. Bands: G	28480	G382A-21	6	2	0
	H	28480	H382A-5	6	2	0
	J	28480	J382A-21	6	2	0
	P	28480	P382A-5	1	2	0
	X	28480	X382A-14	3	2	0
11	Choke Flange					
	Freq. Bands: G	28480	G382A-22	8	2	0
	H	28480	H382A-6	7	2	0
	J	28480	J382A-24	2	2	0
	P	28480	P382A-6	2	2	0
	X	28480	X382A-42	2	2	0
	NOTE: When replacing the end section having the choke as a part of the end section, both the end section and the choke flange must be ordered. In the case of the HP Model G382A, a choke plate HP Stock No. G382A-22 must also be ordered and installed.					
12	End Locator Pin					
	Freq. Bands: G, H, J	28480	5020-0317	1	4	1
	P, X	28480	1480-0015	6	4	1
13	Cover					
	Freq. Bands. G Moss grey finish	28480	00382-20022	5	1	0
	H, J Moss grey finish	28480	00382-20024	7	1	0
	P, X Moss grey finish	28480	00382-20026	9	1	0
14A	End Section (without Resistive Card)					
	Freq. Bands: G Moss grey finish	28480	00382-60001	4	2	0
	H Moss grey finish	28480	00382-60003	6	2	0
	J Moss grey finish	28480	00382-60005	8	2	0
	P Moss grey finish	28480	00382-60007	2	2	0
	X Moss grey finish	28480	00382-60009	2	2	0
	**K	28480	00382-20007	6	2	0
	**R	28480	00382-20014	5	2	0

*See introduction to this section.

**These instruments are of different design and these are the only parts recommended for field replacement.

Table 4. Replaceable Parts List (Cont'd)

Ck Ref. Item	Description	Mfr.*	HP Part No.	CD	TQ*	RS*
14B	End Section (with Resistive Card)					
	Freq. Bands: G Moss grey finish	28480	00382-60002	5	2	1
	H Moss grey finish	28480	00382-60004	7	2	1
	J Moss grey finish	28480	00382-60006	9	2	1
	P Moss grey finish	28480	00382-60008	1	2	1
	X Moss grey finish	28480	00382-60010	5	2	1
	**K	28480	00382-60012	7	2	1
	**R	28480	00382-60011	6	2	1
15	Dial Knob, Freq. Bands: G, H, J, P, X	28480	0370-0038	9	1	0
	NOTE: See note under item 11.					
16	Worm Gear Shaft					
	Freq. Bands: G	28480	G382A-8	8	1	0
	H, J	28480	J382A-5	5	1	0
	P, X	28480	X382A-8	0	1	0
17	Dial Collar, Freq. Bands: G, H, J, P, X	28480	X382A-18	1	1	0
18	Dial, Freq. Bands: G, H, J, P, X	28480	J382A-23	0	1	1
19	Worm Gear Tension Adjustment Spring					
	Freq. Bands: G, H, J	28480	J382A-8	0	1	0
	P, X	28480	X382A-10	5	1	0
20	Worm Gear Thrust Adjustment Spring					
	Freq. Bands: G, H, J	28480	J382A-9	9	1	0
	P, X	28480	X382A-10	5	1	0
21	Offset Gear, Freq. Bands: G, H, J, P, X	28480	5020-0248	7	1	0
22	Stop Gear, Freq. Bands: G, H, J, P, X	28480	X382A-36	9	1	0
23	Ball Bearing, Rear Worm Gear Shaft					
	Freq. Bands: G, H, J	21355	1410-0012	6	1	0
	P, X	21335	1410-0007	9	1	0
24	Rear Bearing Mount					
	Freq. Bands: G, H, J	28480	J382A-6	6	1	0
	P, X	28480	X382A-9	8	1	0
	ITEMS NOT SHOWN IN FIGURES 5 AND 7.					
25	Resistive Card, End Section					
	Freq. Bands: G	28480	G382A-3	3	2	1
	H	28480	H382A-4	5	2	1
	J	28480	J382A-14	1	2	1
	P	28480	P382A-3	9	2	1
	X	28480	X382A-24	4	2	1

*See introduction to this section.

**These instruments are of different design and these are the only parts recommended for field replacement.

Table 4. Replaceable Parts List (Cont'd)

Ck Ref. Item	Description	Mfr.*	HP Part No.	CD	TQ*	RS*
	ITEMS NOT SHOWN IN FIGURES 5 & 7 (Cont'd)					
25	Resistive Card, End Section (cont'd)					
	Freq. Bands: **K	28480	K382A-21B	7	2	1
	**R	28480	K382A-21B	4	2	1
26	Resistive Card, Center Section					
	Freq. Bands: G	28480	G382A-2	2	2	2
	H	28480	H382A-3	4	2	2
	J	28480	J382A-13	9	2	2
	P	28480	P382A-4	0	1	1
	X	28480	X382A-43	4	1	1

*See introduction to this section.

**These instruments are of different design and these are the only parts recommended for field replacement.

APPENDIX
CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
02886	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
21335	Fafnir Bearing Co., The	New Britain, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.

HEWLETT PACKARD

Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

HEWLETT PACKARD

Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

HEWLETT PACKARD

Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

HEWLETT PACKARD

Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

HEWLETT PACKARD

Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

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over

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Should one of your HP instruments need repair, the HP service organization is ready to serve you. However, you can help us serve you more effectively. When sending an instrument to HP for repair, please fill out this card and attach it to the product. Increased repair efficiency and reduced turn-around time should result.

COMPANY

ADDRESS

TECHNICAL CONTACT PERSON

PHONE NO. EXT.

MODEL NO. SERIAL NO.

MODEL NO. SERIAL NO.

P.O. NO. DATE

Accessories returned with unit

☐ NONE ☐ CABLE(S)

☐ POWER CABLE ☐ ADAPTER(S)

OTHER

over

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symtoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

_____

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_____

If unit is part of system list model number(s) of other interconnected instruments. _____

_____

9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symtoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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If unit is part of system list model number(s) of other interconnected instruments. _____

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9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symtoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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If unit is part of system list model number(s) of other interconnected instruments. _____

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9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symtoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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If unit is part of system list model number(s) of other interconnected instruments. _____

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9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symtoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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If unit is part of system list model number(s) of other interconnected instruments. _____

_____

9320-3896 Printed in U.S.A.

Service needed

☐ CALIBRATION ONLY

☐ REPAIR ☐ REPAIR & CAL

OTHER _____

_____

Observed symtoms/problems

FAILURE MODE IS:

☐ CONSTANT ☐ INTERMITTENT

SENSITIVE TO:

☐ COLD ☐ HEAT ☐ VIBRATION

FAILURE SYMPTOMS/SPECIAL CONTROL SETTINGS_____

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If unit is part of system list model number(s) of other interconnected instruments. _____

_____

9320-3896 Printed in U.S.A.

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

HEWLETT-PACKARD SERVICE OFFICES

To obtain servicing information, contact the nearest Hewlett-Packard Sales and Service Office in HP Catalog, or contact the nearest regional office listed below.

UNITED STATES
NO. CALIFORNIA (San Francisco Area)
333 Logue Ave.
Mt. View, CA 94043
SO. CALIFORNIA (Los Angeles Area)
Instrument Repair Center
1421 S. Manhattan Ave.
Fullerton, CA 92631
GEORGIA
450 Interstate N. Parkway
Atlanta, GA 30348
ILLINOIS
5201 Tollview Dr.
Rolling Meadows, IL 60008
NEW JERSEY
W. 120 Century Rd.
Paramus, NJ 07652

AUSTRALIA
Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130

CANADA
Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
Mississauga, Ontario
Canada L4V 1M8

ITALY
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Manual Part No. 00382-90037
Microfiche Part No. 00382-90038

Printed in U.S.A.

ACCO USA
WHEELING, ILLINOIS 60090
25078
50505 25078
RED/ROUGE/ROJO
MADE IN USA